Appendix J3

Mechanical Engineering Design Criteria

Mechanical Engineering Design Criteria

1.0 Introduction

This section covers the design criteria which will be used for all mechanical work related to this project.

2.0 Design Codes and Standards

The design and specification of all work shall be in accordance with all applicable federal and state laws and regulations of California, and with the applicable local codes and ordinances. A summary of the codes and industry standards to be used in design and construction are listed below with clarifications where necessary.

- ASME B1.1--Unified Inch Screw Threads (GE complies at the customer's connection).
- ANSI B1.20.1--Pipe Threads, General Purpose (inch).
- ASME B16.5--Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24.
- ASME B16.9--Factory-Made Wrought Steel Butt Welding Fittings.
- ASME B31.1--Power Piping.
- ASME, Boiler and Pressure Vessel Code/Sec. VIII, Div. 1--Pressure Vessels.
- NFPA30--Flammable and Combustible Liquids Code Handbook.
- ANSI B133.2--Basic Gas Turbine. GE complies, with the exceptions of paragraph: Loose items such as jackscrews and eyebolts are not furnished. Provisions for use of such items are not included in the design.
- ANSI B133.3--Procurement Standard for Gas Turbine Auxiliary Equipment. GE complies fully with design portions only. GE uses its own lube oil flushing procedure. Atomizing air receiver is not applicable.
- ANSI B133.4--Gas Turbine Control and Protection Systems.
- UBC--Uniform Building Code (used for wind loads and seismic design).
- AISC--Structural Steel.

Other recognized standards will be used as required to serve as design, fabrication, and construction guidelines when not in conflict with the above listed standards.

The codes and industry standards used for design, fabrication, and construction will be the codes and industry standards, including all addenda, in effect as stated in equipment and construction purchase or contract documents.

2.3 Piping

Piping will be designed, selected, and fabricated in accordance with the following criteria.

2.3.1 Design Temperature and Pressure

The design pressure and temperature for piping will be consistent with conditions established for the design of the associated system.

The design pressure of a piping system generally will be based on the maximum sustained pressure that may act on the system plus 25 psi. All design pressure values will be rounded up to the next 10 psi increment.

The design temperature of a piping system generally will be based on the maximum sustained temperature which may act on the system plus 10° F. The piping design temperature will be rounded up to the next 5° F increment.

Fire water piping will be designed and tested in accordance with NFPA requirements.

2.3.2 General Design and Selection Criteria

Piping will be designed in accordance with the requirements of the Code for Pressure Piping, ASME B31.1--Power Piping, or other codes and standards referenced in Section 2.2 of this Appendix, as applicable.

Minimum wall thicknesses of straight steel pipe under internal pressure will be designed in accordance with Paragraph 104.1.2 of ASME B31.1.

Allowance for variations from normal operation, consideration for local conditions, and transients will be in accordance with Paragraphs 102.2.4 and 102.2.5 of ASME B31.1.

The value of A (thickness allowance) must be selected to compensate for material removed in threading, corrosion, and erosion, and to provide mechanical strength. The following minimum allowances should be applied:

- Special wall piping 2-1/2 inches and larger--The value of A will be 0.0625 inch.
- Schedule wall piping 2-1/2 inches and larger--The value of A will generally be zero except when additional thickness is considered necessary for a specific service.
- Schedule wall piping 2 inches and smaller--The value of A should be selected to provide adequate mechanical strength. An A value of 0.0625 inch is suggested, but is not mandatory.

- Threaded piping--The value of A will equal the depth of thread.

The pressure temperature ratings for plain end seamless schedule wall pipe will be based on minimum wall values which are 87-1/2 percent of the nominal pipe wall thicknesses with the value of A equal to zero. This will make allowance for the minus 12-1/2 percent manufacturing tolerance on wall thickness.

The pressure temperature ratings for fusion welded, or forged and bored, schedule wall pipe will be based on the appropriate manufacturing tolerances and the required A value.

Material selection will generally be based on the design temperature and service conditions in accordance with the following:

- Carbon steel piping materials will be used for design temperatures less than or equal to 750° F.
- Stainless steel piping materials will be used for piping generally subjected to highly corrosive service applications.
- Fiberglass reinforced plastic piping materials will be used only in applications requiring corrosion-resistant materials.
- Plastic piping having a high coefficient of thermal expansion will be used only after a thorough analysis of the piping system thermal expansion parameters.

The above listed materials, or other suitable piping materials listed in Section 2.3, will be used where required for special service to meet specific requirements.

2.3.3 Miscellaneous Piping Design and Selection Criteria

The minimum pipe size and wall thickness for miscellaneous piping, other than instrument primary piping, will generally be in accordance with the following criteria:

- The pipe size for piping, except as described above, with a design pressure of 600 psi or less, and with a design temperature of 750° F or less, will be 1/2 inch minimum.
- The wall thickness for piping 2 inch nominal size and smaller will be Schedule 80 for carbon steel and alloy pipe, and Schedule 40S for stainless steel pipe minimum.

2.3.4 Instrument Primary Piping Design and Selection Criteria

Instrument primary piping will generally be designed in accordance with the following criteria:

- Piping and instrument diagrams will indicate the size and selection information for piping through the root valves. The line sizes and selection information of tubing piping after the root valves will not be called out on the piping and instrument diagram. The size requirements for instrument primary piping are stated in Appendix H4.
- Pressure connections and piping through the root valves for all pressure indicators, pressure switches, pressure transmitters, etc., will be 3/4 inch.
- Temperature indicators, temperature controllers, temperature switches, temperature detectors, and test well connections will be 3/4 inch NPT.
- Flow transmitter connections and piping through the root valves will be 1 inch for all piping except orifice flanges, where 1/2 inch piping and valves will be used.
- Level switch connections and piping through root valves will be 1 inch.
- Level controllers and level transmitters of the displacement type will have connections and piping through root valves of 2 inches.
- Level controllers and level transmitters of the differential pressure type will have connections and piping through root valves conforming to the requirements for miscellaneous piping in Subsection 2.3.3.
- Level transmitters on tanks and vessels will be installed with isolation valves.
- Instrument columns at tanks and pressure vessels will generally be 2 inch minimum.

2.3.5 Vent and Drain Piping Design Criteria

Vent and drain piping will generally be in accordance with the following criteria:

- Vent connections will be provided at all high points in water and oil piping, and all high points in other piping which will be hydrostatically tested.
- Drain connections will be provided at all nondrainable points in water and oil piping, and all other piping which will be hydrostatically tested.

- All vent and drain connections will be provided with isolation valves. Vent and drains will use full ported valves where practical to resist pluggage. Low-pressure water systems with design pressures of 150 psi or less will use ball valves. Other systems will use gate valves. Alternatively, if the use of full-ported valves is not possible, gate valves will be used.
- Vent and drain connections that require frequent operation or which may discharge significant quantities of fluid will be piped to a suitable drain. Vent or drain connections that will normally require operation at a time when hot fluids will be discharged will be piped to a safe termination point (drain funnel or floor area discharge). All other vent and drain connections will be capped.

2.3.6 Piping Materials

Piping materials will be in accordance with applicable ASTM and ANSI standards. Materials to be incorporated in permanent systems will be new, unused, and undamaged. Piping materials will generally be in accordance with the following criteria:

- Steel and Iron Pipe--Carbon steel piping through 18 inch nominal size will be A106 Grade B seamless with the indicated grades as a minimum.

  Stainless steel pipe will be ASTM A3l2 Grades TP 304, TP 304L, TP 316, or TP 316L piping. All stainless steel piping materials will be seamless and fully solution annealed prior to fabrication. The Type 316 materials will be utilized for high resistance to corrosion. The Type 316L materials will be utilized for applications requiring hot working (welding, etc.), when the piping will handle solutions that are high in chlorides.

  Schedule numbers, sizes, and dimensions of all carbon steel pipe will conform to ASME B36.10. Sizes and dimensions of stainless steel pipe designated as Schedule 10S, 40S, or 80S will conform to ANSI B36.19. Schedule numbers, sizes, and dimensions of stainless steel pipe not designated as 10S, 40S, or 80S will conform to ASME B36.10.

  Steel plate piping will be of the welded straight seam type.
- Ductile Iron Pipe--Mechanical joint or push-on joint ductile iron pipe will conform to ANSI/AWWA C151/A21.51. Flanged ductile iron pipe will conform to ANSI/AWWA C115/A21.15.
- Copper Alloy Pipe--Copper alloy pipe will conform to ASTM B43, Seamless Red Brass Pipe.
- Fiberglass Reinforced Plastic (FRP) Pipe--FRP pipe will be chosen in accordance with the specific service requirements.

- Polyvinyl Chloride (PVC) Pipe--PVC pipe will conform to ASTM D1785 or ASTM D2241.
- Chlorinated Polyvinyl Chloride (CPVC) Pipe--CPVC pipe will conform to ASTM F441 or ASTM F442.

2.3.7 Tubing Materials

Tubing materials will generally be in accordance with the following criteria:

- Stainless Steel Tubing--Stainless steel tubing will conform to ASTM A213, Type 316 seamless. All stainless steel tubing will be of the fully annealed type, with a carbon content greater than 0.04 percent. Stainless steel tubing for use with tubing fittings will not exceed Rockwell B80 hardness.
- Tubing Wall Thickness--Wall thickness for tubing 3/4 inch and smaller, not protected by enclosures, will not be less than the following. Heavier wall tubing will be used where required for specific design pressure and temperature conditions:

Outside Diameter of Tubing	Wall Thickness Stainless Steel
inch	inch
1/4	0.035
3/8	0.035
1/2	0.049

2.3.8 Fitting Materials

Fittings will be constructed of materials equivalent to the pipe with which they are used:

- Steel Fittings--Steel fittings 2-1/2 inches and larger will be of the butt welding type, and steel fittings 2 inches and smaller will be of the socket welding type.
- Butt Welding Fittings--The wall thicknesses of butt welding fittings will be equal to the pipe wall thickness with which they are used. The fittings will be manufactured in accordance with ASME B16.9, ASME B16.28, and ASTM A234 or ASTM A403.
- Forged Steel Fittings--Forged steel fittings will be used for socket-weld and steel threaded connections and will conform to ASME B16.11. The metal thicknesses in the fittings will be adequate to provide actual bursting strengths equal to or greater than those of the pipe with which they are used.

The minimum class rating of socket-weld and threaded fittings used with various pipe schedules will be as follows:

	Minimum Fitting Class Ratings	
Pipe Schedule No.	Threaded	Socket Welding
80 or less	2,000	3,000
120 or 160	3,000	6,000
Double extra strong	6,000	9,000

- Cast Steel Flanged Fittings--Cast carbon steel flanged fittings will conform to ASME B16.5 and will be of materials conforming to ASTM A216 WCB.
- Adapters--Specially designed adapters may be used in lieu of reducing outlet tees for the run and branch sizes specified. Specially designed adapters must be postweld heat treated as specified in ASME B31.1. Specially designed adapters will be Weldolets or Sweepolets as manufactured by Bonney Forge and Tool Works, WFI, or equal.

  Branch connections 2 inches and smaller will be made with special reinforced welding adapters, Bonney Forge and Tool Works Thredolets or Sockolets or equal, or will be special welded and drilled pads.
- Ductile Iron Fittings--Mechanical joint or push-on joint ductile iron fittings will conform to ANSI/AWWA C110/A21.10 and ANSI/AWWA C111/A21.11. Flanged ductile iron fittings will conform to ANSI/AWWA C110/A21.10.
- Cast Iron Fittings--Cast iron fittings will conform to ASTM A126, Class B.
- Brass and Bronze Fittings--Screwed brass and bronze pipe fittings will conform to ASME B16.15. Flanged brass and bronze pipe fittings will conform to ASME B16.24.

- Fiberglass Reinforced Plastic (FRP) Fittings--Fittings for use with FRP pipe will be manufactured from material of the same type as the pipe. Joints will be as required by the application. Filament wound or molded fittings will be used as required by the application.
- Polyvinyl Chloride (PVC) Fittings--PVC pipe fittings will be manufactured from PVC material of the same type as the pipe with which they are used. The fittings will have socket ends with internal shoulders designed for solvent cementing.
- Chlorinated Polyvinyl Chloride (CPVC) Fittings--CPVC pipe fittings will be manufactured from CPVC material of the same type as the pipe with which they are used. The fittings will have socket ends with internal shoulders designed for solvent cementing.
- Tubing Fittings--Stainless steel fittings will be used with stainless steel tubing. Fittings for use with stainless steel tubing in sizes smaller than 3/4 inch will be of the flareless "bite" type. Fittings for use with tubing in sizes 3/4 inch and larger will be socket-weld type conforming in general design to ASME B16.11. Fitting material and bursting strength will be equivalent to the tubing with which they are used.

2.3.9 Flanges, Gaskets, and Unions

Flanges mating with flanges on piping, valves, and equipment will be of sizes, drillings, and facings that match the connecting flanges of the piping, valves, and equipment.

Flange class ratings will be adequate to meet the design pressure and temperature values specified for the piping with which they are used.

Flanges will be constructed of materials equivalent to the pipe with which they are used.

Flanges for orifices will be of the orifice flange type.

Flanges 2-1/2 inches and larger will be of the weld neck or slip-on type and all steel flanges 2 inches and smaller will be of the socket type. Slip-on flanges will generally be used only when the use of weld neck flanges is impracticable. Steel flanges will have raised face flange preparation. Flat face flanges will be used to mate with cast iron, ductile iron, fiberglass reinforced plastic, polyvinyl chloride, chlorinated polyvinyl chloride, or bronze flanges.

Flanges and fittings manufactured in the People's Republic of China shall be in accordance with the 1994 quality assurance program that has been implemented by the

Chinese Center of Boiler and Pressure Vessel Inspection and Research of the Ministry of Labor (CBPVI). Flanges and fittings manufactured under the control of this program shall:

- Be stamped with the mark of the CBPVI.
- Have markings as required by ASME B16.5.
- Bear the official stamp of CBPVI on all relevant quality inspection reports.

Compressed fiber gaskets will be used with flat face flanges. Flexitallic Spiral Wound Gaskets will be used with all Class 150 socket weld flanges and raised face flanges. Gaskets containing asbestos will not be used.

Gaskets will be suitable for the design pressures and temperatures.

Piping unions will be of the ground joint type constructed of materials equivalent in alloy composition and strength to other fittings in the piping systems in which they are installed. Union class ratings and end connections will be the same as the fittings in the piping systems in which they are installed.

2.3.10 Cathodic Protection

Underground carbon steel, stainless steel, copper, or brass piping will be electrically isolated from aboveground piping and other metallic components, and will be provided with a bonded, dielectric coating system to allow the underground piping to be cathodically protected. Isolation from aboveground piping will be achieved by installation of isolation flanges with insulating gaskets, sleeves, and washers. For piping 2 inches and smaller, insulating unions may be used for isolation from aboveground piping. Cathodically protected piping routed into concrete foundations will be isolated from reinforcing steel with a wrapping of polyethylene mesh over the coating system.

2.3.11 Inspection and Testing

Inspection and testing of piping will be performed in accordance with the requirements of the applicable code, and in accordance with the following criteria.

Pressure testing of piping assemblies, including hydrostatic, pneumatic, and in-service leak testing, will be performed on the system assemblies upon the completion of erection. Shop leak testing of piping will not be required. All underground piping to be tested will be given the test prior to covering the line. Testing will be performed in accordance with the following methods:

- Hydrostatic testing of all piping, except as otherwise discussed herein or for which a pneumatic leak test will be provided, will be performed with cold water at 1-1/2 times the design pressure of the piping.

  Piping for which isolation by valving or blanking is impractical (open ended vents and drains after the last valve, safety valve vent stacks, etc.) will not

be hydrostatically tested. Piping between isolation valves and connected equipment that is not leak tested will not be hydrostatically tested. Piping connected to equipment that is leak tested will be hydrostatically tested at the lowest test pressure of items involved in that test (pumps and discharge piping to the first isolation valve will be tested at the pump suction piping test conditions, if the suction test conditions are lower). Temporary piping for use only during construction will not be hydrostatically tested.

- Pneumatic testing will be provided for all pressure piping that should not be subject to water filling. This will generally include the following piping:
  - Lube oil piping.
  - Low-pressure (design pressure less than or equal to l50 psi) compressed gas piping conveying natural gas and ammonia.
  - Compressed air piping.

  Instruments will be carefully protected against overpressure during testing of piping.
- In-service leak testing will be performed for all pressure piping that is not hydrostatically or pneumatically tested by tests that are in full accordance with the applicable code.

Nondestructive testing of piping will be performed in accordance with applicable codes.

2.3.12 Pipe Supports and Hangers

The term "pipe supports" includes all assemblies such as hangers, floorstands, anchors, guides, brackets, sway braces, vibration dampeners, positioners, and any supplementary steel required to attach pipe supports.

2.3.12.1 Design and Selection Criteria. All support materials and their design will be in accordance with the latest applicable provisions of the Power Piping Code, ASME B31.1.

Structure attachment components will be fastened by welding or bolting. Pipe supports will be attached to concrete by cast-in-place anchor bolts, studs, expansion bolts, or plates. Expansion bolts with a minimum pullout safety factor of five will be used.

Expansion bolts will be cone-expansion type, conforming to Federal Specification FF-S-325, Group II, Type 4, Class 1 or 2. Minimum thickness of cast-in-place steel plate bearing against concrete will be as follows:

Supported Pipe Size nominal inches	Plate Thickness inch
4 and smaller	1/4
6	3/8
8	1/2
10 through 18	3/4
20 and larger	1

Pipe attachments will be rigid relative to the piping and insulation and will extend sufficiently outside insulation, if any, to permit free installation and operation of other support components. Insulation protection saddles or components will be used where required to prevent damage to insulation. On piping other than steel or iron, the piping manufacturer's recommendations will be followed.

Material for clamps, lugs, bolts, studs, and nuts will be carbon steel for piping 750° F or less, and will be alloy steel for piping more than 750° F. Piping attachments for nonmetallic pipe will meet the following minimum requirements:

- The minimum recommendations of the piping manufacturer will be met.
- Piping attachments will not bear load by a point. Their width will equal or exceed the square root of the outside diameter of the piping (thus, 4 inch OD piping minimum clamp width equals 2 inches), and they will bear around 120 degrees or more of the circumference.
- In general, clamps will not be clamped tight and hard on the piping. Where piping attachment must grip the piping by clamping, a soft, Shore 50-60 rubber pad will be provided between the clamp and the piping, and the clamp will be formed to fit the padding.

The top surface of riser clamps will be flat and normal to the pipe.

Riser lugs will be sized in accordance with Welding Research Council Bulletin No. 198 and the requirements of ASME B31.1.

Trapezes will be constructed from structural tubing or from double channels positioned back-to-back with space between for the hanger rods and with washer plates welded to channel tops and bottoms. Washer plates shall be used at all hanger rod attachment points.

Hanger rods will be constructed of solid round steel bars. Maximum allowable stress in a rod will be 9,000 psi average at the thread root cross-sectional area, or 12,000 psi in nonthreaded rods. Pipe, strap, chain, or other similar materials will not be permitted in place of rods.

Screw threads will be in conformance with ASME B1.1. Stress areas for threaded rods will be equal to or larger than the following American National Standard Unified Inch Screw Thread Series:

Nominal Rod Diameter inches	Thread Series
3/8 through 4	UNC
4-1/4 and larger	4 UN

Bolting will consist of either studs and nuts or bolts and nuts. Minimum thread engagement will be 100 percent of the nut thread. Nuts for each stud will be installed equidistant from the ends of the stud. Middle portions of studs and shank portions of bolts will not be threaded. Bolt heads and nuts will be hexagonal type, conforming to ASME B18.2. Where no axial load is to be carried, pins with washers and cotter pin retainers will be permitted in place of bolts.

Restraints, struts, and anchors will have the following features:

- Restraints fabricated of structural steel will have a clearance of 1/8 inch, with respect to the restrained component, in the directions of the restrained movement unless otherwise noted.
- All restraints will be designed to withstand the static and kinematic friction due to relative movement of the pipe with respect to the restraints.
- All restraints and anchors will withstand the design loading indicated without buckling.
- All struts will be provided with means for locking the length adjustment. The length adjustment lock will be on the right-hand thread end, if both right- and left-hand threads are used.

Exposed components of shop fabricated pipe supports will be shop painted before shipment to the jobsite. Before painting, surfaces will be suitably cleaned and prepared in accordance with the paint manufacturer's instructions. Bearing surfaces and nameplates will not be painted. These surfaces will be coated with an easily removable rust-preventive compound.

2.3.12.2 Pipe Support and Hanger Materials. Support component materials will be suitable for service at the operating temperature of the pipe to which they are attached. Where support component temperature is below 750° F, component material will be carbon steel or of an ASTM type having a minimum yield strength of 35,000 psi, and a minimum ultimate strength of 58,000 psi.

2.4 Valves

Valve pressure classes, sizes, types, body materials, and end preparations will generally be as described herein. Special features and special application valves will be utilized where required.

Valves specified to have flanged, socket-welded, or screwed connections will have ends prepared in accordance with the applicable ANSI standards. Steel flanges will be raised face type unless otherwise required. Cast iron and bronze flanges will be flat faced type. Butt welding ends will be prepared in accordance with ASME B16.25 and ASME B31.1.

Steel body gate, globe, angle, plug, and check valves will be designed and constructed in accordance with ASME B16.34 as applicable. Valve bodies and bonnets will be designed to support the valve operators (handwheel, gear, or motor) with the valve in any position, without external support.

2.4.1 Steel Body Valves 2 Inches and Smaller

Steel body valves 2 inches and smaller will have forged steel bodies. Forged steel valves complying with the standards and specifications listed in Table 126.1 of ASME B31.1 will be used within the manufacturer's specified pressure temperature ratings and will be limited in accordance with the pressure temperature ratings specified in ANSI B16.34.

- Valve ends will be socket-weld type unless otherwise required.
- Except as otherwise required, check valves will be of the guided piston or swing disk type. All check valves will be designed for installation in either horizontal piping or vertical piping with upward flow.

2.4.2 Steel Body Valves 2-1/2 Inches and Larger

Steel body valves 2-1/2 inches and larger will have cast or forged steel bodies. The face-to-face and end-to-end dimensions will conform to ASME B16.10. Selection of these valves will be in accordance with the pressure temperature ratings specified in ASME B16.34 as applicable:

- Body ends will be butt weld or flanged type.
- Check valves will be of the guided piston, swing disk, or double disk spring check type. The use of double disk spring check valves will be limited to cold water

services. All check valves will be designed for installation in either horizontal or vertical piping with upward flow.

2.4.3 Iron Body Valves

Iron body gate, globe, and check valves will have iron bodies and will be bronze mounted.

The face-to-face dimensions will be in accordance with ASME B16.10. These valves will have flanged bonnet joints. Gate and globe valves will be of the outside screw and yoke (OS&Y) construction. Body seats will be of the renewable type. Gate valves will be of the wedge disk type.

2.4.4 Butterfly Valves

Rubber-seated butterfly valves will be generally constructed in accordance with AWWA C504 Standard for Rubber-Seated Butterfly Valves. The valves will also generally conform to the requirements of MSS Standard Practice SP-67, Butterfly Valves. Valves of the wafer or lugwafer type will be designed for installation between two ANSI flanges. Valves with flanged ends will be faced and drilled in accordance with ASME B16.1. The selected use of butterfly valves will be in accordance with the pressure temperature ratings specified in AWWA C504, the pressure temperature ratings specified by the manufacturer, and as specified in the following criteria:

- Butterfly valves will generally be used for 4 inch and larger cold water services only.
- Butterfly valves for buried service will be of cast iron body material and will be equipped with flanged ends.
- Cast iron butterfly valves will have pressure classes selected based on the piping design pressure as follows:

Piping Design Pressure	Valve Class
25 psi and below	Class 25
Above 25 psi to 75 psi	Class 75
Above 75 psi to 150 psi	Class 150

Cast iron butterfly valves will be limited to use with piping systems having a design temperature of 125°F or less.

- Butterfly valves for other than buried service will be of carbon steel or cast iron body material depending on the service application. Valves will be of the wafer type, or lugwafer type, if used with steel or alloy steel piping.
- Carbon steel butterfly valves will be limited to use with piping systems having a design temperature of 150°F or less. Carbon steel butterfly valves will have pressure classes selected in accordance with the pressure temperature ratings specified in ASME B16.34 for 24 inch and smaller valves.

Metal seated or teflon seal ring seated butterfly valves for special service applications will be of the wafer or lugwafer type and will be designed for installation between ANSI flanges. The use of these valves will be in accordance with the pressure temperature ratings specified by the manufacturer.

2.4.5 Bronze Body Valves

Bronze gate and globe valves 2 inches and smaller will have union bonnet joints and screwed ends. Gate valves will be inside screw, rising stem type with solid wedge disks. Globe valves will have renewable seats and disks.

Bronze check valves 2 inches and smaller will be Y-pattern swing disk type or guided piston type designed for satisfactory operation in both horizontal piping and vertical piping with upward flow.

Bronze valves 2-1/2 inches and larger will have bolted flange bonnet joints and flanged ends. Gate and globe valves will be of the outside screw rising stem construction. Gate valves will have either integral or renewable seats. Globe valves will have renewable seats.

The use of these valves will be in accordance with the pressure temperature ratings specified by the manufacturer. Bronze valves will be limited to service with piping systems having design pressures of 200 psi or less, and design temperatures of 150° F or less.

Bronze valves will generally be limited to a size of 3 inches or less.

2.4.6 Ball Valves

All ball valves will be in accordance with the pressure temperature ratings specified by the manufacturer. Ball valve bodies 2 inches and smaller will have threaded end or socket-weld connections. Ball valves 2-1/2 inches and larger will have flanged ends. The valves will not require lubrication. Ball valves for use with copper piping shall have brazed or screwed ends. Ball valves for natural gas service shall have renewable seats and be firesafe per API 601 as a minimum.

2.4.7 Diaphragm Valves

Diaphragm valves will be straightaway or weir bodies with flanged ends faced and drilled for installation between ANSI flanges. The use of these valves will be in accordance with the pressure temperature ratings specified by the manufacturer.

2.4.8 Plug Valves

Plug valves will be in accordance with the pressure temperature ratings specified by the manufacturer. All valves will be suitable for the intended service. Plug valve bodies 2 inches and smaller will be socket weld, screwed, or flanged. Plug valves 2-1/2 inches and larger will be butt weld or flanged.

2.4.9 Polyvinyl Chloride (PVC) and Chlorinated Polyvinyl Chloride (CPVC) Valves

PVC and CPVC valves will be constructed entirely from polyvinyl chloride, chlorinated polyvinyl chloride, and teflon. The use of these valves will be in accordance with the pressure temperature ratings specified by the manufacturer.

2.4.10 Valve Materials

Valve bodies will generally be constructed of materials equivalent to the pipe with which they are used. Valve body and trim materials of construction will be in accordance with applicable ASTM and AISI standards. Valve body materials will generally be as follows:

Material Name	Description	
Cast Iron	ASTM A126 Class B	
Bronze	ASTM B61 or ASTM B62	
	Forged	Cast
Carbon Steel	ASTM A105	ASTM A216 Grade WCB
Stainless Steel	ASTM A182 Grade F316L or Grade F316	ASTM A351 Grade CF3M or Grade CF8M

2.4.11 Valve Operators

Valves will be provided with manual or automatic operators as required for the service application and system control philosophy. Automatic operators will be motor, piston, or diaphragm type.

Manual operators will be lever, handwheel, or gear type, with the use of lever operators to be limited to valves requiring a maximum of 90 degree stem rotation from full open to full closed position on valve sizes 6 inches and smaller. All operators will be sized to operate the valve with the valve exposed to maximum differential pressure.

2.4.12 Branch Line Isolation Valves

An isolation valve will be provided in 2 inch and smaller branch lines from major headers.

2.4.13 Valve Special Features

Valves will be provided with locking devices, handwheel extensions, vacuum service packings, limit switches, and other special features as required. Locking devices, when furnished, will allow the valve to be locked either open or closed with a standard padlock. Limit switches, when furnished, will be provided for the open and closed position of the valve.

Valves (control) will not be equipped with bypasses unless specifically required.

2.5 Insulation and Lagging

The insulation and lagging to be applied to piping, equipment, and ductwork for the purposes of reducing heat loss, reducing sweating, and personnel protection will be in accordance with the following criteria.

2.5.1 Insulation Materials and Installation

Insulation materials will be inhibited and of a low halogen content so that the insulation meets the requirements of MIL-I-24244 Amendment 3 regarding stress-corrosion cracking of austenitic stainless steel. Insulation materials will contain no asbestos.

All piping operating above 140°F will be insulated with calcium silicate molded insulation in accordance with ASTM C533, fiberglass, or mineral fiber, dependent on the application.

Equipment and ductwork operating at elevated temperatures will be insulated with calcium silicate block fiberglass, or mineral fiber block insulation dependent on the application.

2.5.2 Lagging Materials and Installation

All insulated surfaces of equipment, ductwork, piping, and valves will be lagged.

All aluminum lagging will be ASTM B209 Alclad 3004 or acceptable equal. All aluminum lagging will be stucco pattern embossed.

2.5.3 Insulation Supports for Piping

Vertical runs of piping, which will be insulated, will utilize support lugs and collars to prevent slippage of the insulation.

2.5.4 Insulation Classes for Piping and Equipment

Piping and equipment insulation classes and corresponding thicknesses are designated by letters, which will be indicated in the design documents.

The insulation for piping accessories will be of the same class as is indicated for the piping. Insulation materials for miscellaneous piping and equipment will be suitable for the actual operating temperatures.

For piping systems operating above 140° F where the retention of heat is not necessary for proper operation, such as vents and various drains, the insulation thickness shall be reduced to that necessary to maintain the surface temperature of the insulation at approximately 140° F.

2.5.5 Freeze Protection

(Not Applicable).

2.5.6 Antisweat Insulation

All aboveground cold water and air piping will be provided with antisweat insulation.